


SPACE CLEANER

A stylized graphic of a rocket launch, consisting of several thin black lines that form the outline of a rocket's trajectory, starting from the bottom left and curving upwards and to the right, passing behind the main title.

IDC ROBOCON 2015

Context

Beginning in 1957 with the launch of the satellite Sputnik by the Soviet Union, humanity began to shoot for the stars. However, with this journey also came space debris – defunct objects orbiting around the Earth. These objects are a potential hazard for the functioning satellites and people stationed in space. It is estimated that there 21,000 pieces of space debris larger than 10 centimeters in orbit, and half a million pieces that are 1-10 centimeters (Figure 1). These numbers are predicted to increase. In addition, there are also millions of pieces of debris smaller than 1 centimeter. In the lower parts of orbit around Earth, objects travel at 7 kilometers per second. At this speed, a tiny speck of paint has the same effect as a 250 kilogram object traveling at 97 kilometers per hour. Not only can these small particles damage important modules such as pressurized items and tethers, but they can also create new debris upon impact. According to NASA, an average of one cataloged piece of debris has fallen back to Earth each day for the past 50 years.



Figure 1. Artistic Rendering of Earth's Debris

In recent years, various space organizations have reduced the amount of trash added to Earth's orbit by implementing better designs. However, cleaning the debris from orbit is still a problem that needs to be addressed. There have been plans of taking trips to larger objects to remove them from orbit, but this comes at a high financial cost.

Objective

You will design and built robots to remove the space debris from orbit and return the debris back to earth.

General Guidelines

1. These rules are intended to create opportunities to innovate and test new ideas which are fundamental to gaining confidence as an Engineer.
2. The IDC referees and staff will make final scoring judgement calls and interpretations of the rules.

3. Everyday there will be a dedicated team leaders meeting and it is compulsory for atleast one representative from each team to be present for the meeting. Any rules discussion and decision would be made during this meeting only.

Game Field

1. The game field will consists of three zones: The outer orbit where the debris are present, the space across which the debris has to be transported and the earth which is the final destination for the debris. The detailed dimensions and views are given in Figure 2, 3 and 4.
2. Earth on the game field will rotate to simulate the orbiting space debris.
3. Earth consists of dedicated regions for each team to deposit the debris collected by the robots for scoring points which is further divided into two areas – an outer shell area and a more elevated but smaller inner shell area.
4. Deployment of robots are restricted to a dedicated safe zone within the orbit and the entire space zone.
5. The entire arena is split into two parts one for each team and strictly no crossover of robots are allowed beside the Center zone. Any robot that enters opponent's arena would be taken out of the field for the rest of the game.
6. Starting point of the robot located in Space zone will be a 600mm x 600mm square beside the orbit zone and the outer side boundary of the space zone. The starting point of the robot located in the Orbit zone will be a 400mm x 600mm rectangle beside the terminal edge of the Orbit Zone
7. Any part of the robot is allowed to go over the center zone, however, any part of the robot crash the outer orbit inside the center zone is also considered crash the outer orbit anywhere else in the game field

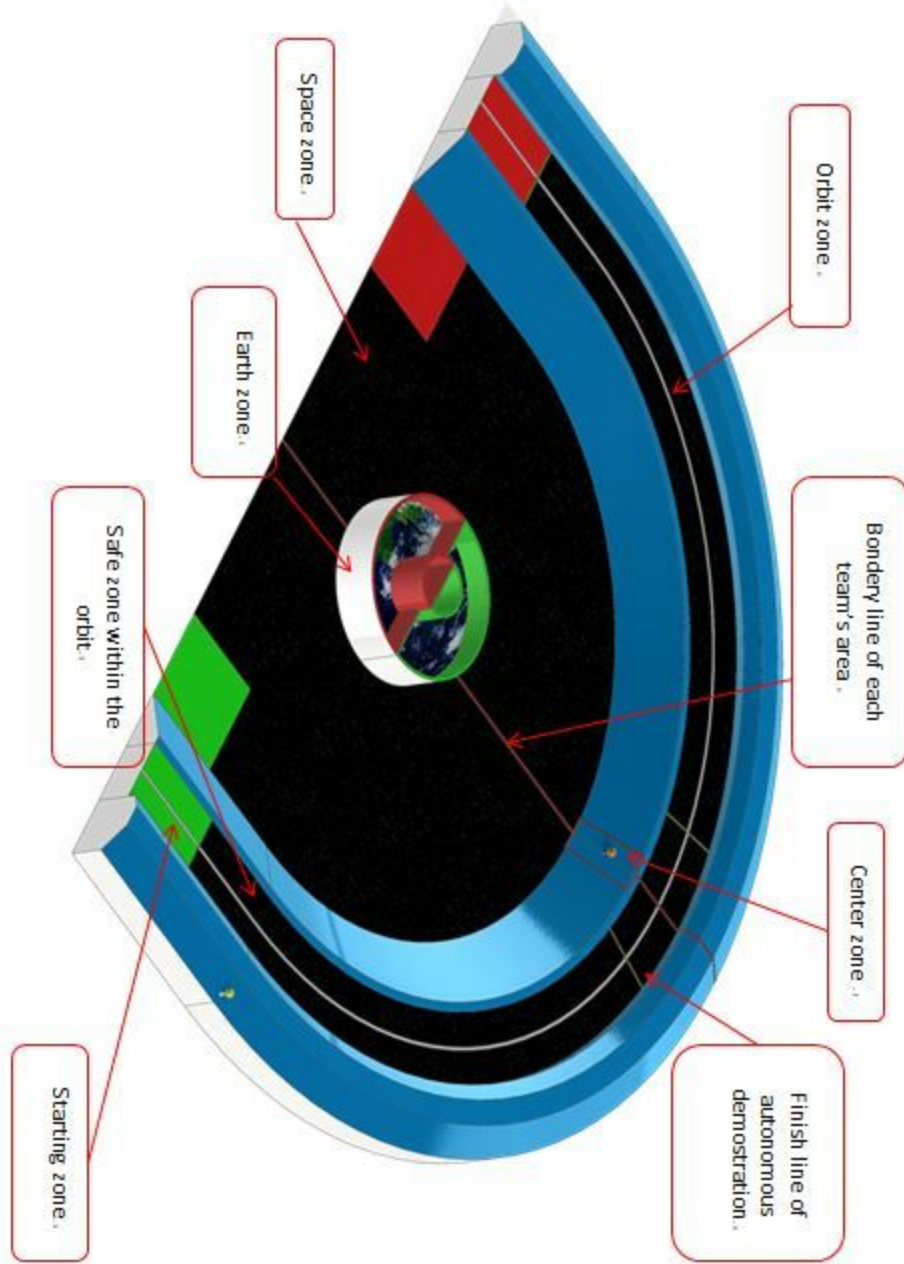


Figure 2. Game Field Description

Objects

1. There will be three types of debris objects within the game field colored in white, yellow and orange with varying points allocated to each. Debris are made from foam balls with a diameter of 50mm.
2. There will be a total of 81 debris out of which 40 of them are scattered in each of the two regions dedicated for the teams and one orange debris located at the boundary line between the regions. Out of the 40 debris located within each region, 12 of them are yellow debris, and 28 of them are white ones. The location of the debris are suggested by Figure 5. The Yellow colored area is where yellow debris located, the white areas are where the white debris located. The orange point will be where the orange debris located.

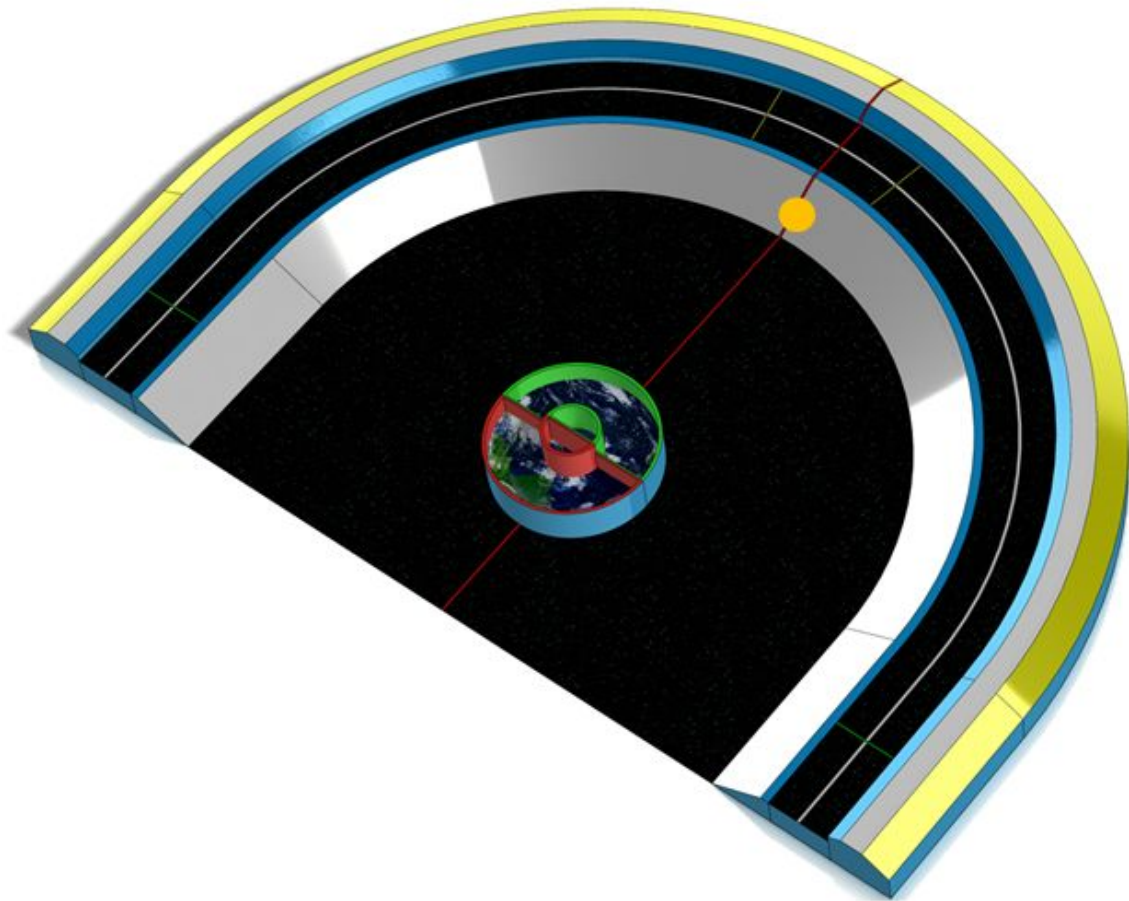


Figure. 5 Debris locating map

3. Debris that fall off of the game field are unplayable.
4. The debris will be located on the top of a diameter 30mm tube as the Figure. 6 shows.

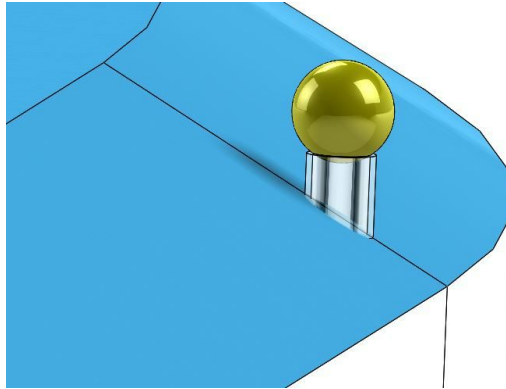


Figure. 6 Locating mechanism of the debris

Robots

1. Each team is allowed a maximum of 2 robots.
2. Your entire robot must be made from the kit materials and materials purchased using the funds (SGD 50) allocated for each team. All components purchased out of the kit must be authorized by one of the official referees. Screws, bolts, nuts, washers, stick glues, vinyl tape, welds and many other materials are prepared for the teams at the workplace.
3. The maximum allowable robot size is 600mm x 600mm x 600mm. Robots can be designed with active deployable mechanisms with no size restrictions.
4. The total weight of each robot must not exceed 5kg.
5. You can use the machines in the fabrication lab for example bench drilling machines, band saws, benders, 3D printers, laser cutters and hand tools. You may ask the technical facilitators in the fabrication lab and IDC staff on how to access them.

6. Each robot must be defined either to operate in orbit or space zones and they are expected to stay in their respective zone for the duration of the match. The robot in orbit must stay in orbit zone and the robot that's deployed in the space must stay within that area at all times.
7. Teams can decide to put one robot in orbit and space zone or both robots in one of the two zones.
8. For robots that fall off the defined area, team members are allowed to place them back onto the field for a restart from the starting area. However, a penalty will be levied.

Scoring

1. To score, the team must transfer the debris from the orbit zone back to their respective regions on earth. The debris are color coded and the worth of each colored debris is listed below in Table 1.

Table 1. Points allocated for colored debris

Color	Points
Orange	Doubles total score
Yellow	30
White	10

2. When the team deposits the debris into the outer shell area of the Earth, they get the points listed in Table 1. For each debris transferred into the smaller elevated inner shell of the Earth is worth three times the points allocated for that colored debris except for the orange debris which doubles the total points when deposited anywhere into the team's earth region.
3. Whenever a robot goes out of the respective play area defined and/or crashes on either sides of the outer orbit, or any part of the earth zone, a penalty of 120 points would be levied with a restart from the starting area.

4. Teams that demonstrate autonomous line following from starting area to the demarcated boundary line will be awarded an additional 120 points. This demonstration has to be done within the allocated game play time for the team.

Schedules and Timing

1. The contest consists of qualifying rounds and a final competition.
2. The qualifying rounds will take place on 31st of July morning 9am -12nn.
3. The final tournament will be on the 31st of July evening 4pm – 6pm.
4. The qualifying round is 150 seconds, and final tournament is 180 seconds.
5. If a game is finished in a tie, the following tie-breaking rule is applied; a game of 30 seconds to collect a single orange debris placed at the boundary line is run. The team that collect and deposit the orange debris will be declared as the winner in that game. This tie-breaking rule is applied until a winner emerges.
6. There will be 3 minutes time for the team to prepare their robot before the game start.

Control

1. Team members are only allowed to control their robots.
2. All controls must be realized without any physical contact with the robot.
3. Control may be achieved via wireless means only. No wired connections to the robot out of the game field would be allowed.
4. A contestant found to have deliberately interfered with the opponent or another team's robot during a game will be disqualified.
5. If defective of the robot happen during the game, team members can go in the game field and remove the defective robot from it under judge's permission. The robot will have to start from the starting area after it's removed from the game field.

Conduct and Safety

1. Damaging, overturning, pushing and lifting an opponent's robot is not allowed outside the center zone.
2. Damaging the game field and or control equipment is strictly forbidden.
3. During the workshop time and competition time, participants are supposed to respect and protect the game field. Steping, moving, jumping over the game field is strictly forbidden.
4. Contestants and or spectators may not directly affect the motion of the robot.
5. After the time limit, the referee judges the winner of the match according to the points scored by the competing teams.
6. No dangerous machines. Technical facilitators and IDC staff's decisions on safety must be respected and obeyed at all times.
7. Team members controlling the robot must wear safety glasses near the game field. Certain prescription glasses are acceptable.
8. Scratch or stab the debris are allowed

General Enquiries

General questions may be asked of all participating faculty, technical facilitators and IDC staff. However, all officially sanctioned rule interpretations will be made by the referees. The key decisions will be discussed every day during the team leader's meeting. The questions and answers will be also achieved at the IDC RoboCon 2015 website.

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